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THE SUGAR RESEARCH SCHEME.

PLANT PHYSIOLOGY AND AGRICULTURE.

INSECTICIDES FOR THE CONTROL OF CERTAIN TRINIDAD CROP PESTS.

FURTHER STUDIES IN TROPICAL LAND TENURE.

WEST INDIAN NOTES.

PRICE 6d.

R.C.W. 1925.

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

THE SUGAR RESEARCH SCHEME.

THE Governing Body has recently announced that several of the sugar companies in the British West Indies have agreed to contribute to the funds of the Department of Sugar Technology. This is welcomed as a sign that the research and training work of the Department are appreciated by the commercial sugar interests, and also that they are anxious that its activities should be extended.

When the College first started, a valuable asset was and still is an Instructional and Experimental Sugar Factory. The equipment therein was donated by the members of the British Sugar Machinery Manufacturers Association and the total value of the gifts was in the neighbourhood of £20,000. The late Mr. Claude Berthon together with Mr. George Mayes designed the plant which is capable of grinding three tons of cane per hour. It is complete in every respect and sugar can be produced by several different processes. Periodically, new or additional machinery has been installed in order to modernise the equipment, and a set of pressure, temperature, vacuum, CO_2 and pH recorders has been added. Further extensions and additions are contemplated which, it is hoped, will be completed in the coming years. Similarly, modern laboratory apparatus has been acquired from time to time so that accurate measurements may be carried out on the various juice constituents.

Provision has therefore been made for both the teaching and the investigational work of the Department. As regards the former, the course is one of four years. At the end of the third year, which includes fundamental training both in the College factory and in commercial factories, the successful student is awarded his Diploma, and then proceeds to a fourth year for his Associateship. It is during this year that the student becomes closely associated with the current research work, since one aspect of it is assigned to him and forms the basis of his thesis. Whenever necessary, the Experimental Factory during its grinding period is operated so that appropriate samples can be obtained for subsequent analysis. Furthermore, the local commercial factories have not been backward in offering facilities for confirmatory work on a larger scale.

The limiting factor hitherto has been the shortage of staff and the impossibility of providing enough funds to allow the Department its full scope. Most of these difficulties have now

disappeared through the generosity of the sugar companies in creating the fund. The greater proportion of the money has been promised for a period of seven years. With such a foundation and with the appointment of an Assistant Sugar Technologist, the research can be planned over a period so that the various problems can be systematically examined. Suitable arrangements, it is hoped, will be made so that the Sugar Technologist and his Assistant can constantly maintain contact with the contributors factory staffs. This will ensure that their points of view are obtained and will prevent the work from becoming too fundamental in nature. It follows that some of the factory and laboratory work may have to be carried out at the contributors factories, and a portion of the money has been allocated for this purpose. This should not be taken to mean that the investigational work will be directed towards the solution of immediate or temporary factory problems, although this work might, if necessary, be undertaken. The return from any research investment is obtained in the form of increased yields, higher recoveries and lower costs and such results cannot be obtained instantly. As other British cane sugar manufacturers, not necessarily in the West Indies only, become interested in the scheme and further expansion takes place there appears to be no reason why the College should not become the recognized training school in sugar technology for the Empire just as Louisiana has for the United States. The adequate training of their technologists in a well equipped school is a method of reducing costs often overlooked by the factory operators. Most of the students who come to the College are drawn from the Caribbean area with a few from India. It is hoped that in the future men will also come from other parts of the Empire. Equipment and facilities such as are available here are not available in all British sugar growing countries and, from the purely business point of view, only part of the capital cost required to provide such facilities in each country need be invested to finance suitable men for training at Trinidad.

In conclusion, may we quote Mr. C. F. Kettering who said "If you have no problem in your business, if you are perfectly satisfied with your product, your processes and your costs in all rspects, if you have no trouble from competition or other sources of worry, and are sure you are not going to have any for ten years then you *may* not need research ".

REVIEWS.

CACTI.

By Professor J. Borg, M.A., M.D., *Macmillan & Co. Ltd.*, London, 1937, pp. 419. Price 21*s*.

This is a specialist publication, and will appeal only to systematic botanists and to the select circle of gardeners interested in the bizarre family of plants with which it deals. To them, however, it will doubtless prove essential. It contains 45 pages of introductory matter, mainly concerned with cultural details, and 335 pages devoted to classification, and descriptions of all the recognized genera and of most of the species. It has all the marks of an accurate and authoritative monograph, the production is good, and there are 47 excellent photographic plates illustrating 93 species.

E. E. C.

* * *

CHRONICA BOTANICA.

Vol. IV, No. 1 Annual subscription, 7.70 guilders, post free, from Chronica Botanica Co., P. O. Box No. 8, Leiden, Holland.

Chronica Botanica, formerly a yearbook, has become a bi-monthly "International Plant Science News-magazine". Its scope is wide, and if there are differences of opinion about the value of some of the sections, each critic is likely to find something to approve. One section is reserved for scientific communications as a medium for the quick publication of short or preliminary notes on recent researches or new discoveries. Another is for scientific discussions and critical reviews. About half the publication consists of miscellaneous news and personalia of interest to practitioners of all the sciences that deal with plants. This is the original feature, and the one by which the usefulness of the new venture is likely to be judged. No other publication known to the reviewer provides a similar service on an international basis, and *Chronica Botanica* therefore fills a gap and may be expected to become popular. Contributions are accepted in English, German, French, Italian and Spanish, but the greater part of the number under review is in English.

E. E. C.

* * *

SCIENTIFIC HORTICULTURE.

Vol. VI, 1938. Price 4*s*. 6*d*., post free, from the Hon. Editor, *South-Eastern Agricultural College*, Wye, Kent.

Horticulturists in the Tropics who like to keep in touch with developments in England will find much of interest in *Scientific Horticulture*, the annual journal of the Horticultural Education Association. Volume VI (1938) deals with a variety of subjects, from the flower industry to school gardening, in veins ranging from completely non-technical to distinctly technical. Short of reproducing the Contents page, it is difficult to do justice to the whole, but the plant pathologist, breeder and physiologist will find here important scientific papers in their subjects. The practical grower of plants on the extensive scale usual in the Tropics may be interested in reading about some of the trials and triumphs of the really intensive grower who can calculate gross returns in terms of pounds (sterling) per square yard.

E. E. C.

PLANT PHYSIOLOGY AND AGRICULTURE.

By H. R. Barnell.
(*Low Temperature Research Station.*)

Introduction.

The green plant, directly or indirectly, is the food of man while agriculture is the industry concerned with the production of food for the world's population. The primary occupation of agriculture is, therefore, the culture of the plant, the efficiency of the industry depending on raising the maximum amounts of produce without loss of assets in terms of soil or its fertility. In the past, empiricism, or the method of trial-and-error, has resulted in the evolution of methods of plant and land culture which have been "efficient" in the sense of providing a sufficiency to meet the demand made on the produce of the land by its inhabitants. But as this demand increases, or as present systems of production become uneconomic, the old method of seeking to effect improvements in cultivation may not only prove cumbrous, slow and labour-wasting, but may also exercise a restricting influence on the utilisation of valuable innovations inherent in scientific discoveries. The view may therefore be advanced that every effort should now, and in the future, be made to approach the problems of agriculture through the medium of fundamental research in plant physiology. In practice, the appropriate combination of empirical and fundamental methods is likely to be most productive of useful results.

The Assessment of Yield.

The problems of satisfying increased demands for plant products, or of raising the returns on a particular crop to a profitable level, resolve themselves into the question of "yield". The yield of a plant may be the whole mass of plant produced, its fruit, its seed, its stem or its roots or some part of any of these, or appendages. Yield is determined by hereditary constitution and by the conditions under which the plant has been grown; it can be regarded as the integration of the metabolic processes concerned in growth and development until the harvesting period is reached. It follows that before the factors determining yield can be analysed with any exactitude it is necessary that our knowledge of the fundamental problems of plant metabolism should be greatly increased; only then may the effect of variation in any one environmental factor on the life of the plant be forecast with assurance. The only way, in fact, in which the ideal of providing a plant with the most favourable environment for producing its maximum yield can be attained, is by the study of metabolic processes and their reactions to varying external factors. Until this information is available we cannot even suggest a value for the maximum yield of a particular crop and hence we have no fixed standard by which to assess the "efficiency" of present day systems of cultivation. Of new systems introduced today it can only be said that they are improvements or otherwise on past systems.

The maximum yield of a plant will be obtained when its environment is so arranged that its many metabolic processes are collectively functioning under optimal conditions throughout the life of the organism. Any plant of the same genetical type which is not producing this maximum yield may then be considered to be 'pathological', *i.e.* suffering from an excess or deficiency of some environmental factor or from the attack of a parasitic organism. It is safe to say that, judged by this physiological ideal of maximum yield, very few crop plants today would be regarded as 'non-pathological'.

Scope and Limitations of Modern Plant Physiology.

In its modern form the science of plant physiology is barely adolescent: no one of the fundamental problems of plant life can be said to be fully understood. Work is still being carried out on the mechanism of photosynthesis, respiration, transpiration and translocation in plants. While some partial efforts have been made there has not yet been completed anything that may justly be regarded as affording a full physiological and biochemical study of the development of a single plant.

In the agricultural industry the application of plant physiology has so far been of limited extent, and has largely consisted in "explaining" the various current modes of cultivation. For example, modern study has shown that major operations such as ploughing, liming, supplying humus, &c., all tend to increase yield by increasing the available supply of nutrients to the plant—a direct consequence of keeping the soil "open" whereby more efficient aeration and rapid oxidation of the weathered rock become possible. This preliminary elucidatory phase of the application of plant physiology to agriculture represents the essential "catching up" of a new science to an ancient industry; in brief, it has been necessary for the science as a first aim to understand as far as possible, the fundamental nature of practices at present in operation.

The next approach is to suggest from knowledge of the plant's metabolism improvements on existing methods. It is the purpose of this article to consider the application of fundamental research in plant physiology to agriculture and the results which may be expected to accrue. Already in one branch of the industry—the transport and storage of perishable agricultural produce—it may be claimed that physiology has taken its place and that from an early stage

fundamental researches have played their part in preparing the way for extended commercial application. In no other branch of agriculture has plant physiology yet had such an opportunity to contribute but it will be of interest to consider its present bearing on the industry in general.

The basis of agriculture is the green plant grown in the soil. The plant requires from the soil: anchorage, nutrients and water, the last two in suitably balanced quantities. For physiological studies, however, sand or water cultures are preferred, as, in general, better and more uniform plants can be produced than in soil which rarely contains the right balance of nutrients or possesses the best physical state for the encouragement of growth; moreover, soils vary considerably in physical and chemical composition even when obtained from a limited area of land. Intensive agriculture (particularly glasshouse culture of fruit and vegetables) is tending more and more to apply sand or water instead of soil culture to its crops because of the more standardised growing conditions obtained and the consistent better yields produced. Agriculture in general, however, must of necessity remain content with the soil. The aim of applied physiological research will be to attempt to ascertain the best use to which the soil and prevailing climate can be put. As knowledge of the interaction of plant metabolism with external factors increases, the selection of plants to suit particular environments should become a matter of less uncertainty than at present. Cultivation methods will also be modified to provide the nearest approximation to the environment most favourable for the plant.

Physiology and Pathology.

The extension of a single crop to large scale production usually brings numerous problems in its train, among others liability to disease in epidemic form, *e.g.*, the onset of Panama and Leaf-Spot diseases of the banana plantations in Central America and the Caribbean. It is cogent to enquire what assistance the physiologist is likely to be able to render in the future to the pathologist in his efforts to reduce such diseases. Since some aspects of every disease are referable to derangements of the normal metabolism, it follows that for the full understanding of the pathological condition physiological investigations will also be required. The difficulties in the way of general advance along these lines at present lie in the relatively slow rate of advance of physiological knowledge due, in part, to the few workers engaged in that science. It is not possible to carry out more than a superficial investigation into the disordered metabolism of a diseased plant while the metabolism of the "healthy" plant is not understood (for practical purposes a "healthy" plant is here understood to be one showing no apparent symptoms of disease, and if a crop plant, providing a satisfactory yield). Thus, one of the results of an attack of "leaf-spot" (*Cercospora musae*) disease of bananas is premature ripening associated with abnormal colour, flavour and odour of the pulp; while the causes underlying the initiation of ripening in the healthy banana remain unknown, only provisional hypotheses can be made concerning the manner in which the fungal attack diverts the normal metabolism of the fruit. All too frequently in the early days of plant pathology, a disease was considered adequately investigated and the problem, so far as agriculture was concerned, closed, once a causal organism had been found, named, and some control measure suggested: whereas the discovery of a causal organism (or of the absence of such an organism in so-called "physiological diseases"), should, in fact, be regarded as a starting point for specialised physiological study both of the pathogen and its host.

Except in those instances where a plant is genetically weak all morbid metabolic states are attributable to external factors. These may include: a deficiency of water supply; deficiency of some essential element in available form; deficient oxygen supply due to over-crowding or to water-logging of root systems; excess of some element or elements or carbon dioxide; or, the external factor may be an alien organism which competes for the synthesised food materials of the plant and perhaps, simultaneously secretes a toxin having an additional deleterious effect on the metabolism of the plant. Any combination of one or more of the above factors may be responsible for disease: in all cases the disease is a diversion of the normal metabolism of the plant as grown under ideal conditions.

A single factor, the excess or deficiency of which, in conjunction with the inroads of parasites, is responsible for more pathological conditions than any other, is that of water supply. Water in excess of a plant's requirements or, presented unequally so that periods of excess occur, though the rainfall over the whole season may barely provide an adequate supply, results in water-logging of the roots, decreasing the respiratory activity of their tissues by reducing the rate of diffusion of oxygen to their surfaces, causing stunted root development with consequent poor growth of the whole plant and inability to cope with temporary drought periods. Water deficiency in the soil results in many pathological symptoms including wilting, little-leaf, defoliation, and stunted growth generally.

These examples represent part of the toll of disease due to variations in the intensity of a single factor of the plant's environment. Each of the other environmental factors (nutritional and other elements in the soil, oxygen, light, &c.) may be present in excess or deficiency and each add its quota of possible pathological states. Combinations of various deficiencies and excesses will produce complex abnormal plant growth. The optimum intensity for each factor can only be elucidated by research, which is made particularly difficult by the interdependence of the factors in their effects on the plant (*e.g.* light

intensity and temperature, temperature and water supply). Fortunately each variety of plant can tolerate a more or less wide range about the optimum intensity of each factor without any serious pathological condition being induced.

Plants growing under conditions near the limit of their range with respect to a particular factor may be subnormal and therefore less resistant to attack by those parasites for which the conditions are nearly optimal. Thus fungal parasites in general grow and spread most rapidly under conditions of abundant water supply and high humidity, hence crop plants already partially crippled by conditions of water-logging are liable to more virulent infection by fungal pests than those grown under more satisfactory conditions of water supply.

Restoring conditions to a closer approximation to the optimum for a crop's growth will assist in the combating of alien organisms producing specific diseases. Thus, draining modifies conditions in the right direction for crops suffering from excess of water while the application of fertilisers, to supply deficient essential elements in the soil, also modifies the plant's environment but in a complex manner.

The influence of environmental factors on the incidence of disease has been much discussed by pathologists and numerous investigations have been carried out both in the field and under controlled conditions. As a result the conditions favouring disease incidence or otherwise are now at least partly known for many diseases of major importance. Nevertheless, to obtain the desired measure of control it will be necessary to carry the analysis of disease problems far beyond the present stage.

Complex Action of Fertilisers.

Fertilisers, as mentioned in the preceding section, act on the soil and on the plant in numerous ways, the understanding of which is not easy. Addition, in available form, of an element definitely demonstrated as deficient in the soil is almost invariably beneficial but in exceptional cases it may so disturb the balance of the chemical-physical-biotic soil complex as to produce deleterious effects on plant growth. The modes of action of a fertiliser on the soil and on the plant are too numerous to discuss at length so are briefly summarised:—

(1) The physical properties of the soil are altered.
(2) Availability of other soil constituents may be affected.
(3) Concentration of the soil solution is changed.
(4) Reaction (pH) may be altered.
(5) Balance between certain soil constituents, *e.g.* magnesium-calcium antagonism, may be corrected or disturbed.
(6) Biotic balance (bacteria, nematodes, &c.) is modified.
(7) May act as toxin towards plant or may protect against toxins already present.
(8) May serve directly as a plant nutrient.
(9) Decreases "water requirement" of plant, increasing efficiency in utilisation of scanty water supply.
(10) When absorbed by the plant increases its resistance towards specific diseases, *e.g.* salts of lithium increase resistance of wheat to mildew (*Erysiphe graminis*), Spinks (1913), Wortley, W. R. S. (1936).
(11) May render plants poisonous to pests, *e.g.*, selenium salts and thrips on cotton, Mason, T. G. and Phillis, E. (1938).

It is clear that with so many diverse actions of a fertiliser on the soil and on the plant many important changes may escape detection in empirical experiments and much possible information be neglected. Even when the yield is not increased, in a trial with a particular fertiliser, biochemical and physiological study may reveal differences of fundamental importance. Once comprehensive knowledge is available concerning the metabolical and morphological reactions of a plant to variations in its environment much greater use than is possible at present could be made of the plant as an indicator of the soil and climate in which it is grown, pointing the way to success or failure of other crop plants grown under similar conditions.

Importance of Fundamental Knowledge.

In the past empirical methods have given sufficiently good results in agricultural research but only after long experience. The *tempo* of modern life demands that problems shall now be attacked by methods likely to give speedy solutions. Such methods must essentially be based on an exact knowledge of the functions and requirements of the plant, whereby the best conditions for its culture can be deduced with some considerable degree of exactitude. Empirical methods will almost certainly also be required for the final testing of deductions from physiological science but their application will be much more in the nature of a crucial experiment than heretofore.

For example, in modern fruit storage investigations, by studying the metabolic activities of a particular fruit in relation to each of the several external factors (temperature, humidity and gaseous composition of the atmosphere) information should be obtained indicating approximately the most favourable storage conditions: empirical trials can then be confined to a small range, and will therefore gain both in accuracy and value. So too, in crop production increase in fundamental knowledge should decrease the amount of empirical work necessary and materially advance the solution of practical problems.

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INSECTICIDES FOR THE CONTROL OF CERTAIN TRINIDAD CROP PESTS.

By Alan Pickles, M.Sc., A.I.C.T.A.
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The present paper is an attempt to suggest methods for the control of local insect pests by simple and inexpensive means. No originality is claimed for the formulae or for the methods quoted, but practically every recommendation is made after field trial has proved its suitability for local conditions.

Insect pests may be controlled by three essentially different methods, known respectively as chemical, cultural and biological control. Chemical control aims at the direct destruction of insects by means of poisons. Cultural control attempts to prevent or to destroy insect outbreaks by special re-arrangement of the ordinary processes of cultivation or to stimulate plant growth in such a way that insect attack is avoided or is survived without appreciable economic injury. In biological control, the natural enemies of the pest insects are utilized to reduce the numbers of the pest below the level at which serious injury occurs.

Cultural control, employing slight modification of routine agricultural practice, rarely involves any special expenditure for pest eradication. Biological control may involve fairly large costs before efficient natural enemies are discovered and established, but in the majority of successful cases, it is self-maintaining when once established and does not involve recurrent expenditure.

During recent years, cultural and biological means of control have received considerable attention. Where such methods are practicable they possess undoubted advantages over chemical methods, but successful cases of cultural and biological control are relatively few in number, although the proportion of such instances will doubtless increase as time goes on. In the vast majority of cases, therefore, chemical methods are necessary if insect outbreaks are to be controlled and generally have to be employed pending the discovery of suitable biological or cultural methods.

In Trinidad in particular, chemical control is practised only to a very small degree as compared with many competitor countries. The reasons for this are somewhat complex and, in the past, have probably been well justified. Trinidad is perhaps unusually rich in the natural enemies of pest insects and has been, thanks to the industry of the late F. W. Urich, one of the important countries from which the natural enemies of such insects have been obtained for utilization abroad. Thus, scale insects, which in most tropical countries are among the most serious pests, are comparatively unimportant in Trinidad, owing to the activities of entomogenous fungi and of predaceous insects which together keep the scales in satisfactory control in most districts.

Again the high cost of materials and the difficulties of their application in the tropics have also had a most important influence. Most of the local staple crops are cultivated on an extensive principle, the margin of profit per unit of area being small. A small extraordinary expenditure for pest control may therefore absorb the whole of the profit, and often it is actually cheaper for the planter to bear the loss of crop caused by a pest than to spend money in attempting to control it.

It appears, however, that there is considerable room in the agriculture of Trinidad for the successful employment of insecticides, both by large planters and by small proprietors. The neglect of even ordinary maintenance on many cacao estates during the last few years, a direct result of the lamentable state of the market, seems undoubtedly to have been accompanied by an increase in the incidence of pests and diseases. In addition, this depression of the cocoa industry has led to the establishment of new crops, each presenting entomological problems of its own, which are naturally less familiar to the planter than are those of the older crops.

In the sections which follow, details are given of methods which fulfil the conditions of economy and efficiency as far as possible. Especial reference is made to insecticides which can be prepared by the planter himself from ingredients readily obtainable in the colony. While the vast majority of ready-made insecticides are undoubtedly efficient, it is a fact that home made preparations can often replace them at a fraction of the cost.

The Use and Preparation of Insecticides.

(*a*) The Application of Insecticides to Plants.

With the exception of ants, bees and similar insects, most injurious species actually reside upon the plants which they injure for a significant part of their life. Insecticides are therefore applied directly to the plants so that the pests will come into contact with the poisonous substances or will actually consume a part of the insecticide along with their normal food. Those preparations, which must be eaten before they can affect the insects, are known, as "stomach poisons"; they are employed to coat the whole of the plant which is attacked to ensure that every insect is affected. Other insecticidal preparations are effective if they merely come into contact with the insects; they are known as "contact insecticides" and need not be ingested with the food.

It is therefore evident that stomach poisons may be employed to prevent an outbreak of insects by poisoning the surface of the food plant

before insects reach it. Contact insecticides, on the contrary, are only of value in destroying existing infestations. Stomach poisons again are only useful in the control of those insects which feed upon superficial tissues; they are useless for the control of sucking insects such as scales, aphides, froghoppers and leafhoppers and against many weevils and boring insects. The choice of an insecticide for a particular pest has therefore to be made with some care.

Insecticides of both types may be applied as sprays or as dusts. In the case of sprays, the insecticide is applied as a suspension of a poisonous substance in water or, less commonly, as a solution in water. Where large areas are to be treated, the amount of water required for spraying may become impracticably large. Indeed, transport of water under local conditions usually represents the greater part of the expense of spraying.

Dusts require no water for their application; they are applied in the form of very fine powders from special bellows or blowers. The dusting method, however, is more extravagant in material than is the wet spray method and this offsets to some extent the advantages of the saving in labour. A given area can be dusted more rapidly than it can be sprayed and, with unskilled labour, dusting can be accomplished more efficiently. Which of the two methods can be carried out more cheaply depends upon individual circumstances.

Spraying machines are of many different types, ranging from small portable machines operated by hand to large power-driven machines. The Department of Agriculture will be glad to advise on the selection of a pump for any particular purpose. When small areas only have to be treated, particularly when the plants to be sprayed are of small size, the type of sprayer illustrated in fig. 1 is recommended. This is now obtainable in the Colony at a reasonable price and should prove a valuable investment to any planter, farmer or gardener. The pump unit, of which the handle is seen at the top of the tank in the illustration, may be removed, allowing the spray fluid to be poured directly into the tank. The pump is then replaced and the tank is charged with compressed air by giving about 30 strokes of the pump. The operator now swings the machine on his back and has both hands free for work. Extension rods may be used when tall trees are to be sprayed and the nozzle may be adapted to throw either a fine spray or a straight jet.

Dust blowers also may be hand-operated or power-driven. One type of small power blower which has been found extremely satisfactory is illustrated in fig. 2. As an index to the capabilities of this machine, it may be stated that it will dust effectively 60 bearing citrus trees per hour with the help of three men under local conditions.

Labourers unaccustomed to insecticide work require a period of training before they are efficient and, when spraying is undertaken for the first time, progress is usually extremely slow and the quality of the work is poor. The usual faults in spraying are (i) failure to cover the under side of the foliage and (ii) a tendency to linger too long on a small part of the tree. Efficient dry dusting is much easier to obtain with unskilled workers and the usual fault is to use an excessive amount of material. It should be remembered that, in most cases, a thin layer of insecticidal dust, which is almost invisible without the aid of a lens, is enough to protect the plant. Adherence of dust is best obtained by working in the early morning when the leaves are covered with dew, or after a light shower.

(*b*) Stomach Poisons.

In a paper of the scope of the present, it is obviously impossible to deal in detail either with all the insecticides which may be of value or with all the pests for which treatment may be required. Mention will therefore be made of a selected number of insecticides useful for local conditions and indications will be given of the types of insect against which each may be used.

Fig. 1.

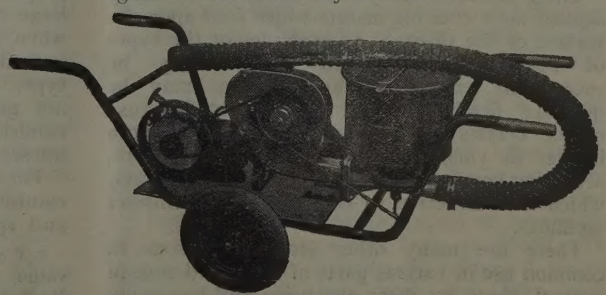

Fig. 2.

Arsenic, in its various forms, is a stomach poison of most general utility in pest control. All arsenical insecticides are highly poisonous and the greatest care should be observed in using them. They are never to be employed on garden produce, such as fruit and vegetables, which is nearly ready for market as the produce may bear a dangerous quantity of the posion and may lead to the death or illness of the consumer. On young fruits and vegetables there can be no objection to the employment of arsenic, unless it be used in excessive amounts.

In Trinidad, Paris Green is a familiar type of arsenical insecticide. Paris Green, however, contains a large proportion of soluble arsenic and has, in consequence, a strong tendency to scorch the foliage to which it is applied. In order to avoid injury to foliage, Paris Green may be mixed with three times its own weight of hydrated lime (i.e. white lime, not temper lime). The mixture is most conveniently applied as a dry dust and, for use on a small scale, may be tied up in a bag of thin cotton material and distributed by shaking or beating the bag over the plants to be treated.

Owing to the variable composition of Paris Green and its tendency to scorch foliage, lead arsenate is to be preferred as a wet spray for foliage; the formula for making the spray is:

Standard lead arsenate powder ...	2-4 lb.
Water	100 gals.

A good quality lead arsenate, especially prepared for use as an insecticide, should be employed. Ordinary commercial lead arsenate often contains an undesirably large amount of soluble arsenic and may be in the form of a coarse powder which will not remain in suspension in water, so that its distribution on the sprayed plants is very irregular. It is often of advantage to use a "spreader" with lead arsenate sprays, in order to maintain an even suspension of the powder in the liquid. There are various types of spreader in use, including skimmed milk, calcium caseinate, flour and glue. If the grower wishes to prepare his own spreader, flour or glue will probably be the most readily obtainable. Flour should be used at the rate of one to two pounds per 100 gallons of spray fluid; glue should first be mixed in a little warm water and added to the dilute spray at the rate of one ounce per 100 gallons. Ready-made spreaders may also be obtained and are usually satisfactory.

These arsenical sprays and dusts are of utility against most chewing insects which feed upon the surface of the plants. As examples of the types of insect against which arsenic may be successfully employed, the following may be quoted: flea-beetles attacking peas and beans; chafer beetles defoliating citrus trees; cocoa beetles in young cultivations; fall-army-worm, attacking young corn plants; cabbage web worm, which is destructive to cabbage and cauliflower seedlings.

There are many other stomach poisons in common use in various parts of the world and, in general, these are more expensive and less easily obtainable than the arsenic compounds. The cabbage web worm mentioned above is a particularly destructive pest to young cabbages and cauliflowers and details for its control, together with much useful information on cultivation, have recently been published in this Journal*.

(c) Contact Insecticides.

Most contact insecticides are preparations of relatively complex organic substances. Many of them, such as nicotine, pyrethrum and derris are plant products. Pyrethrum and derris possess the important advantage of being non-poisonous to human beings and to stock.

Preparations of certain mineral oils are among the most useful and the cheapest of all contact insecticides. They are employed particularly against such sucking insects as aphides and scales but they are also used in the control of many soft-bodied insects. There are numerous proprietary emulsions on the market which are reliable and effective. Many of these however, are somewhat expensive, as they utilize ingredients of unnecessarily high quality for local conditions. Home-made emulsions may be prepared which, for certain purposes, are actually more effective than the expensive commercial emulsions. The oil employed for this purpose is Shell Diesolene, which is emulsified with potash-whale-oil soap. The following ingredients are required to make 20 gallons of stock emulsion:—

Diesolene	16 gallons.
Water	4 gallons.
Potash whale oil soap ...	24 lb.

The ingredients are mixed in a metal tank beneath which a fire is kindled and the mixture is raised to boiling point. When boiling, the fire is drawn and the liquid is pumped while still hot through a fine or medium nozzle of an ordinary spray pump. Pumping the liquid emulsifies the ingredients into a creamy-white, homogenous emulsion, which will mix perfectly with water. For use, this stock emulsion is diluted with 40 to 80 parts water. The efficiency of the insecticide is often increased by adding a generous teaspoonful of nicotine sulphate (40 per cent.), to each gallon of diluted emulsion. This corresponds to one part of nicotine sulphate in 800 parts of spray.

This emulsion is somewhat troublesome to prepare but the trouble is well worth while when large quantities are to be used as, for example, when a citrus cultivation, heavily infested by scale insects, is to be sprayed. Emulsions of this type, which employ soap in their preparation, are generally more effective than proprietary emulsions in removing sooty-mould from scale-infested trees.

For the control of scale insects on citrus, the emulsion should be diluted with 40 parts of water and spraying should be conducted at intervals

* Wood, R. C. and James, H. M.—Cauliflower Cultivation in the Tropics. *Tropical Agriculture*, XIII, No. 8, 1936.

of about a month. As the scales reproduce most rapidly during the dry season, it is advisable that a special spraying campaign should be made at this season. The emulsion may be used as a general garden insecticide for the eradication of caterpillars, aphides and other soft-bodied insects. For this purpose it is diluted 1 : 60 or 1 : 80. The use of oil emulsion on tomatoes is not recommended as the foliage of these plants appears to be particularly susceptible to the action of soap.

In the garden, nicotine and soap may be used as a contact insecticide for the control of caterpillars, aphides and slow moving insects of most kinds except scale insects. The mixture consists of :

Nicotine sulphate	1 pint.
Potash-whale-oil soap	4 lb.
Water	...150 gals.

For small quantities, mix one teaspoonful of nicotine sulphate and two tablespoonfuls of potash-whale-oil soap with one gallon of water. The solution should be freshly made as it deteriorates on keeping for any length of time.

"Mulsulphol", prepared by Trinidad Leaseholds Ltd., is also a contact insecticide of considerable utility. It is employed diluted with water at concentrations varying from one to four per cent. Mulsulphol however, is markedly injurious to the foliage of certain plants and should therefore be used with some caution. In case of doubt, it is advisable to make a trial on a single plant before treating a large number. On limes, Mulsulphol may be used with safety, but on oranges and grapefruit, its use may be attended by a leaf-shedding and by the scorching of young fruits.

Sulphur dusts and sulphur sprays are of value against certain classes of pest. Their most important use is in the control of mites, especially red-spider and the rust-mite of citrus. The latter is probably the most serious and widespread pest of citrus in the Colony, and is responsible for the unsightly discoloration of a large proportion of the oranges and grapefruit produced.

Sulphur comes on the market in various forms and it is important, in the interests of economy and efficiency, that the most finely powdered sulphur obtainable should be used. The so-called "sulphur flour" should be distinguished from "flowers of sulphur"; the former is pulverized rock sulphur, while the latter is sublimed sulphur, consisting of much finer particles than the former. It is generally advisable to employ a good quality sulphur especially prepared for insecticidal purposes. For dusting purposes, sulphur may be applied pure or mixed with one-third of its weight of hydrated lime. Flowers of sulphur or ordinary dusting sulphur will not mix with water and, if a wet spray is required, the so-called "wettable sulphur" should be used. Alternatively, dusting sulphur may be rendered wettable by the admixture of soft soap as follows :

Dusting sulphur ...	...1 lb.
Potash-whale-oil soap ...	...2 lb.

Mix the ingredients together thoroughly, adding a little water if necessary to facilitate mixture. This quantity is sufficient to make 20 gallons of spray on dilution with water. The average bearing citrus tree, six or seven years old, will require about half a pound of sulphur dust or between one and two gallons of sulphur spray.

Pyrethrum and derris form the basis of several very popular insecticides, including most of the commercial fly sprays. Such garden insecticides as "Garden Flit" and "Evergreen" also contain a pyrethrum base. Pyrethrum mixtures are particularly useful to the vegetable grower, as they are entirely non-poisonous and may therefore be applied with safety to vegetables which are almost mature. "Evergreen" and "Multicide" are available in the Colony and may be employed against a large number of pests such as flea-beetles, caterpillars, aphides and plant bugs, with a good deal of success. These pyrethrum extracts should be diluted for use according to the detailed instructions furnished by the manufacturers; the dilution varies according to the type of pest from one part of extract in 200 parts of water to one in 800. Such insecticides are accordingly very economical in use.

(*d*) Repellents.

In addition to plant protection by the active destruction of pest insects, plants may also be guarded against insect attack in certain circumstances by the use of repellent materials which are avoided by the pests. Bordeaux Mixture, which is principally employed as a fungicide, is also a useful insect repellent and it seems possible that it may also act as a stomach poison and as a contact insecticide in certain cases.

Bordeaux mixture contains the following ingredients :—

Copper sulphate (bluestone)	... 4 lb.
Temper lime	... 4 lb.
Water	...20 gals.

Slake the lime very slowly with a little water; it is important that the lime should at first be merely moistened, as it will not slake properly if it is flooded with water. When thoroughly slaked, add ten gallons of the water to the lime. Meanwhile, dissolve the bluestone in ten gallons of water, using a wooden tub for the purpose. It is most important that metal vessels should not be used, as they are attacked by the copper sulphate. Bluestone may be most easily dissolved by tying up the crystals in a cloth bag, which is suspended just below the surface of the water. When both liquids are prepared, pour the bluestone solution into the milk of lime, with constant stirring. The liquid so prepared should be light blue in colour, never green.

Bordeaux mixture so prepared is chiefly employed in Trinidad for the control of cacao thrips. Trees liable to attack should be thoroughly sprayed during the dry season, after the March change of leaf. It may be necessary to repeat the treatment in August or September, if much new foliage has been produced. The sprayed trees are completely protected against thrips attack if the work has been done

thoroughly and the treatment may protect large areas by preventing excessive breeding in the spots which are ordinarily most susceptible.

Many garden crops also may be protected against insect pests by spraying with Bordeaux mixture. It is recommended for the treatment of tomatoes which are subject to the attacks of plant-sucking bugs and for protection against slugs and snails.

An antiseptic wound dressing, which also acts as a repellent against wood boring insects, employs the same substances made into the form of a paste and known as Bordeaux Paste. The ingredients are :—

A.

Bluestone	...3 lb.
Water	...2 gals.

B.

Temper lime	...6 lb.
Water	...2 gals.

Dissolve the bluestone and slake the lime separately in the amounts of water stated. Then mix together equal quantities of each ingredient, making up only enough for one day's use at a time.

Bordeaux paste may be used as a wound dressing on citrus trees, but the use of Bordeaux mixture should be avoided in citrus cultivations whenever possible, since its use tends to favour the increase of scale insects through destruction of their natural enemies. Other repellents will be mentioned in the discussion of special methods for the control of ants.

Special Methods for the Destruction of Ants.

Of all the ants affecting cultivations in Trinidad, probably the most important is the parasol ant or "*bachac*". The usual method of control takes the form of exploding carbon bisulphide, known locally as "Calypso", inside the nests. This method is not particularly effective, especially in the case of large nests, for the destruction of which, several applications are usually necessary. The method also may be dangerous when it is employed to destroy nests occurring in close proximity to buildings. The explosion may be of destructive violence and there may also be some fire risk.

"Cyanogas", which has recently been tested by the Department of Agriculture, is a much more efficient fumigant and, if the instructions of the manufacturers are carefully followed, destruction of ant nests will result from one application of the poison at a cost much below that of Calypso. This method also avoids the risk of damage to property through fire or explosion. Cyanogas, it is true, evolves a highly poisonous gas when in contact with moist air, but provided that a few elementary precautions are taken there should be no possible risk. Operators should stand to windward when manipulating Cyanogas and should avoid bringing the powder close to the face. The substance should be handled in the open air or at least in a very well ventilated room.

In order to use Cyanogas for the destruction of ant nests, a special foot-pump (fig. 3), prepared by the American Cyanamid and Chemical Corporation and now obtainable in the Colony, is recommended. The method advocated by the manufacturers and found highly successful in recent tests made locally, is as follows. If the nest is a large one, first cutlass grass and bush growing upon it so as to expose all the entrances and vents of the nest. Charge the glass dust container of the pump with Cyanogas dust and introduce the side tube into one of the main entrances of the nest. With the dust control lever set at "dust" give four or five strokes with the pump so as to drive poison into the nest and then switch the control lever to the "air" position. Continue pumping until dust begins to rise from the vents in communication with the entrance hole. These holes should now be sealed and a second set of nest chambers is treated in a similar way. Repeat the process until dust has been blown into or out of every hole in the nest when the treatment may be regarded as complete. Should there be any signs of renewed activity later, it may be safely assumed that a series of holes has been overlooked at the first treatment. In the case of small nests made by young colonies, the cost of treatment is negligible and large ones, measuring 20 feet or more square, are eradicated at a cost of about 60 cents.

It is important that the pump should be thoroughly cleaned after use. The jar must be emptied of any remaining powder and its top and the part of the pump into which it screws, together with the adjacent metal parts of the pump, should be thoroughly washed with water. If necessary, these parts may be scrubbed with a small brush. If this is neglected, either the jar will leak badly when next used or it will become immovably jammed. The piston of the pump should also be lubricated with a few drops of light machine oil after use.

Where large or moderately large nests occur at the foot of valuable trees, particularly if these are of small size, it is inadvisable to employ Cyanogas in this way or to explode the nest with Calypso as, in either case, there is a serious risk of killing the tree. The nest may be exposed by removing the surface soil with a fork and then sprinkled with the smallest possible quantity of Cyanogas and subsequently flooded with water.

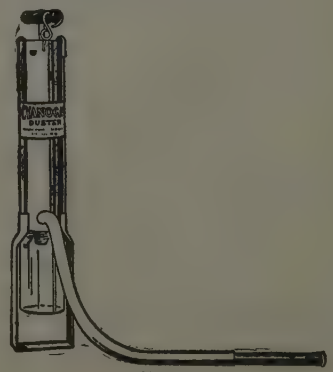

FIG. 3.

The application of water to the open nest disperses the gas from the dust very rapidly and reduces the chances of the delicate roots remaining for a long period in intimate contact with the poisonous vapour. When small ornamental plants or shrubs are similarly situated with regard to a parasol ant nest, it is usually desirable to dig up the plants carefully before treating the nest and to replace them about a couple of hours after treatment is completed.

Ants of many other species are frequently extremely troublesome to cultivations, particularly to citrus plantations and to vegetable gardens. One of the worst offenders is a small stinging ant of the genus *Solenopsis*. These ants make small nests in the soil often close to the base of the tree or among herbaceous plants, which they damage by the removal of the bark or of soft tissue near to the growing points. This results in erratic and misshapen growth and often in the death of the parts of the plants affected.

The nests of these and other ants may often be fumigated without danger to the vegetation. The external opening of the nest should be enlarged with a pointed stick, about a saltspoonful of Cyanogas is introduced into the nest and the opening is immediately closed. When nests occur in close proximity to young trees, especially citrus trees, this treatment may be dangerous. It is inadvisable to fumigate nests which occur within four feet of the base of the stem. In such cases, poisoned baits will be found useful, provided the ant in question is attracted to sugar. The best of these preparations contain thallium sulphate, a poison with a delayed action which allows the ants feeding on it to return to the nest and to exchange poisoned food with the other members of the colony before death supervenes.

In this way, when only a small proportion of the inhabitants of the nest have fed directly on the poisoned bait, the whole population may be destroyed. One such preparation is on sale locally and members of the Co-operative Citrus Growers Association may obtain from the Association a poisoned bait prepared by the Department of Agriculture.

In use, a small piece of the jelly, about the size of a pea, is placed on a slip of paper or wood and the slips are distributed wherever the ants are active. Reliance should never be placed on a single large mass of jelly placed near the nest, as this will be covered with earth and avoided by the ants after a short time.

Small ant nests may be destroyed without the risk of injury to vegetation by pouring diluted pyrethrum extract into the opening of the nests. In the case of "Evergreen", the extract should be diluted with 300 parts of water. The material is too expensive for use in large nests, but may be employed in the case of those ants which make small nests on the foliage of trees as well as for the destruction of ants in the soil.

It frequently happens that the nests of ants injuring vegetation cannot be detected immediately or, for some reason, cannot conveniently be destroyed. In such cases, the trees may be encircled with a repellent band which the ants will not cross. For this purpose, there are several useful formulae, but the ingredients usually include corrosive sublimate, a virulent poison which is not readily obtainable by the general public. The use of corrosive sublimate however, does not appear to be essential and good results may be obtained by replacing it with flowers of sulphur. A typical formula for repellent banding is :—

Banding grease ("Ostiko" or "Tanglefoot") ...	...6 parts.
Corrosive sublimate or flowers of sulphur	...1 part.

The ingredients are mixed together and the resulting paste is spread on strips of stout brown paper which are then fastened around the lower parts of the tree trunks.

A waterproof varnish, to be applied in the same way consists of :—

Corrosive Sublimate ...	100 parts by weight.	
Rum spirit	30 do.	do.
Shellac	15 do.	do.

The sublimate is dissolved in the spirit and the shellac is then added to make a fairly stiff varnish which dries quickly. Preparations containing corrosive sublimate should be stored in glass, never in metal vessels.

Banding grease, suitable for the first recipe may be made as follows. Mix equal quantities of molasses and either linseed or crude castor oil. Heat until nearly boiling and add about an equal weight of powdered resin, stirring well. The exact amount of resin required may be determined by cooling a small quantity of the mixture from time to time and testing the consistency.

It is hoped that the foregoing remarks may serve as an introduction to the subject of insecticidal control of insect pests for local readers. The recommendations are to be amplified later by more specialized publications dealing with individual crops, but it is felt that the suggestions already given should prove useful to most planters and gardeners. An effort has been made to mention, so far as possible, products which are readily obtainable in the colony and to dispell the notion that pests control by means of insecticides is necessarily prohibitively expensive.

The writer is greatly indebted to various commercial firms for the loan of blocks illustrating this article. For Fig. 1, thanks are due to the F. E. Myers Co., Ashland, Ohio; for Fig. 2, to the American Cyanamid & Chemical Corporation and for Fig. 3, to Messrs. W. J. Craven & Co. Ltd., Evesham, England.

Dr. C. W. Wardlaw's series of articles on the Storage and Transport of Tropical Fruits and Vegetables which was published in Vol. XIV, Nos. 3-12, 1937 of *Tropical Agriculture* is now published in the form of a reprint [price 4*s*. 0*d*. (British) and 4*s*. 6*d*. (foreign) post free] which may be obtained from the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

FURTHER STUDIES IN TROPICAL LAND TENURE.

By H. M. Leake.

(*Continued from Tropical Agriculture,* Vol. XV, No. 5, p. 99.)

I.—INDIA.

The Land Revenue System.

The fundamental assumption underlying the Indian tenure system is that the land is the property of the State and this position receives practical demonstration in an annual tax, the Land Revenue. In imposing this tax, the Government has merely adopted the indigenous system of the country which dates from the Hindu period but was developed to a high degree of efficiency under Akbar.

It would, perhaps, be more accurate to say that the system was adapted rather than adopted; for one very significant change was made. Earlier systems calculated the claim on the gross produce, which claim, when the demand amounted to some 90 per cent. as laid down by the Moghuls, had the effect of driving marginal land out of cultivation and was responsible for the vast areas of uncultivated land and the poverty of the country-side. That introduced by the British, while leaving the amount of the demand at the same figure of 90 per cent., substituted for the gross produce the nett produce. The Land Revenue, thus, assumed the form of an economic rent. The change and the reactions to it have been well described by Anderson.*

The incidence of the Land Revenue claim has to be considered under two heads as it is applied in the case of zemindari tracts where a landlord (zemindar) exists with a tenantry paying rents—a system found widely spread in Northern India—or in the case of ryotwari tracts, where the cultivator holds his tenure directly from Government—a system prevalent in Southern India, in Madras and Bombay. The extent of the claim in the first instance, on the establishment of British rule, is shown by Regulation II of 1793 which laid down that the Government share of the produce, which is the basis of the assessment of the claim, should be fixed, in the case of zemindars, by estimating the rents paid by tenants, deducting therefrom the cost of collection, allowing the zemindars one-eleventh of the remainder as their share and appropriating the balance, ten-elevenths, as the share of the State.† In the case of ryotwari tracts, the assessment had to take direct account of those fluctuations which, in the case of zemindari tracts, are indirectly accounted for in the rent and it is natural, therefore, to find wide divergencies in the claim measured as a percentage whether of the gross value of the produce or of its nett value after liberal deductions for cultivation had been made. As a maximum, the claim amounts to 20 per cent. of the gross produce.

*F. G. H. Anderson.—Some Facts, Fallacies and Reflections concerning the Land Revenue Systems in India; 4th Intl. Conf., Land Value Taxation, 1929.

† Land Revenue Policy of the Govt. of India, 1920.

The claim has, since these early days, been much reduced but its essential character remains. It is not in the nature of a pepper-corn rent, a nominal sum the function of which is merely to give annual reminder that ultimate ownership rests with the State; it is a claim for an appreciable share of the produce and, as such, constitutes an overhead charge on production. Two points of major interest arise from this fact of a by no means negligible claim for Land Revenue:—

(i) It is a claim to a share in the produce and, since actual division of the produce itself is no longer possible or desirable—for such division would result in the accrual to the State of any additional produce resulting from betterments which were the work of the landholder or tenant—it is fixed as a cash payment which is an approximation to the average productive capacity of the land. The assessment of the Land Revenue claim, known as the settlement and carried out by Districts, is, thus, a complex matter, for it must take cognizance of the fertility and amenities of each field. It is on these that the productive capacity of the land depends. It must also take cognizance of the improvements made either by the landlord or tenant and make due allowance for these. Being a cash assessment, it must also take account of the value of the produce.

(ii) Such a detailed assessment, taking as it may three or four years for a single District and costing a considerable sum, cannot be made at frequent intervals. Except in what was formerly Bengal, an area which now includes parts of Bihar and the United Provinces, which was permanently settled in 1793, the usual settlement period has been 30 years. After that period a new settlement was undertaken and, in this, adjustments were made to any alterations in rentals, amenities and prices. The system, therefore, is a modified system of taxation of land values and is designed to secure to the State a share in the incremental value of the land. But it is an approximation only, for it is an average, taking into account none of the seasonal fluctuations nor the price changes which may take place during the run of the settlement. The brunt of any adverse change under these heads is borne directly by the cultivator or indirectly by the zemindar through inability to realize his rents. Much of the benefits from favourable changes will, in like manner, accrue to the cultivator even in zemindari tracts owing partly to the normal lag in rents but also to the limitations imposed by Government on the increase of rentals as detailed in the earlier series of these studies.

The system, with all its complexities, has been built up since the commencement of the British occupation, through times when export markets

were expanding and local prices were undergoing enhancement to accord with world prices. Until recently, therefore, each assessment resulted in an enhancement of the previous assessment, a fact which fitted very well with the growing cost of Government. Further, the cultivator reaped the benefit of such enhancement as occurred between settlements. By the end of the Great War the concordance between local and world prices was complete; prices, too, had reached a maximum. It has remained for the post war period and the slump in prices which accompanied it, to afford the first real test of the efficacy of the system, of its flexibility to meet rapid changes, particularly in price levels, to which the world has become accustomed in recent years.

It will probably be granted that the major function of the Land Revenue claim, apart from the provision of a source of income to Government, is to ensure that only so much of the incremental value of the land shall be appropriated as will prevent speculation in land values and the establishment of a rentier class; the danger implicit to such a development had received practical demonstration in the permanent settlement in Bengal. That settlement was determined on in the belief that, by giving the zemindar the whole of the increment, a class would arise which corresponded to the yeoman farmers of England. Further, the magnitude of the increment which would follow on the establishment of the pax Britannica and from the rise in prices as local prices approached those current in the world market, was not realized. In actuality, a rentier class with its accompaniments of absenteeism and rack-renting became firmly established. It is stated by Anderson (*loc. cit.*) that the loss which has resulted to the public revenues of India from this permanent settlement amounts to £12 million a year. That sum is a measure of the gift contributed by the temporarily settled provinces mainly to the zemindars of Bengal. The scale of the Land Revenue claim, thus, becomes a matter of considerable importance for, if a policy of reduction be adopted, a speculative value may result.

In practice, a policy of reducing the claim as far as is compatible with its financial needs has been adopted by Government for some time past and the present maxima are 50 per cent. of the zemindars' nett assets and 20 per cent. of the gross produce in ryotwari tracts. Frequently the claim is much less, 35 and even 25 per cent. in the case of zemindars. Anderson is not alone in claiming that these rates are too low to check speculation in land. Curtis, in his evidence before the Joint Select Committee on the Government of India Bill in 1919, stated that the Local Governments had used their power to reduce assessments below the true value and developed a system by which sub-cultivation and purchase of land by vakils, &c. as an investment became possible, thus building up a rentier class.*

* Rep. Committees; 1919, 4, p. 610.

But changes in the system of administration of the Land Revenue resulted from the introduction of the Montagu-Chelmsford reforms. The Joint Select Committee drew attention to the fact that both the term of settlement and the pitch of the assessment could be fixed and altered by executive order and, among the changes introduced by the reforms, were the devolution of the Land Revenue system entirely to Local Governments and the authorization of the details of the settlement as to term and of the assessment as to pitch by the Local Legislatures. In consequence Land Revenue or settlement Acts have been passed by the Local Legislatures since the introduction of the reforms. Prior to these the term was normally 30 years throughout India, now there is no common period. Thus, in the Central Provinces, the Central Province Settlement Act VI of 1929 fixes the term at 30 years with the qualifications that, if expedient, it may be extended to 40 years or, if developments such as roads, rail or canals, or the existence of abnormally low rents renders it advisable, the term may be reduced to 20 years. The pitch of the assessment is fixed at 50 per cent. of the 'malguzari' assets but may be reduced for specified reasons by the Local Government; where the pitch is higher, it is to be reduced to 50 per cent. by stages at subsequent settlements.

The United Provinces Land Revenue Act I of 1929 is more complicated. It includes a realization that the settlement of a district is a costly proceeding and orders an enquiry prior to the expiry of the existing settlements on the following points:—

(i) whether a reasonable increase, defined as an increase which will recoup expenditure in ten years, of Land Revenue is likely to result and, if not,

(ii) whether the current assessment has become uneven or unduly severe.

If neither queries are answered in the affirmative, the current assessment is to be maintained. The term of settlement is fixed at 40 years with shorter periods in special cases. The pitch of the assessment is fixed at 40 per cent. of the net assets with reduction to 38 per cent., if such reduction does not lower the demand, and to a minimum of 25 per cent. where circumstances are particularly severe, *e.g.* precarious tracts. Further, no increase is to be greater than one-third of the existing demand unless the new demand is less than 30 per cent. It will be noted from this how far the Land Revenue has drifted from being an implement to check speculation in land values.

It is, with these examples, unnecessary to refer to other Provinces in detail. The general trend is towards lengthening the term of the settlement and reduction in the pitch of the assessment. The former is, no doubt, a response to the cost of settlement but, in other respects, must be considered a retrograde step. Price enters largely into the calculation of the assessment seeing that this is a cash estimate of the share of the produce; and no one can foresee the trend of prices over

the coming 40 years. Further, India is undergoing a period of rapid development of communally provided amenities. Roads, particularly feeder roads to the railways, are being provided but, of greater importance, are irrigation facilities. The Sukkur Barrage has thrown open to assured cultivation and settlement a large tract of almost complete desert; the Sarda canal has made secure an extensive area of country already densely populated and intensively cultivated. These are abrupt changes and can, relatively easily, be met by a single resettlement. This is not the case, however, with the hydro-electric scheme which has spread its beneficient tentacles over an equally large tract of Northern India and provided the means of irrigating areas which, if individually small, the unit being a tube well, are collectively large. The changes here take effect irrespective of the date of settlement; moreover, they have a value not necessarily bearing a relation to a water rate determined by the need for securing a return on the capital cost. The reduction in the pitch of the assessment is a natural response to a demand which has been voiced for many years. It is a natural demand which any group selected for special taxation will inevitably make and such *ex parte* demands require to be regarded with caution. Meanwhile, the danger of too great reduction has been pointed out.

Nowhere during the course of the official discussions does there appear to be indicated any clear recognition of the approximation of the Land Revenue system to a tax on land values or of the advantages to be derived from accepting it as such.

In its present form, its main drawback is its inflexibility. That inflexibility, that incapacity to adapt itself to rapidly changing conditions, is largely due to the length of the settlement operations and, in consequence, to the cost. Price changes, as recent experience has shown, are not so stable as appeared when the system was being perfected and maladjustments have arisen for which *ad hoc* remedies have had to be improvised. Any system which would render the assessment more flexible by reducing the term would be beneficial. The solution must be sought in the cost and a consideration of modern methods of assessing land values, of which the world offers numerous instances and under which revision is a very rapid and inexpensive process, would be worthy of consideration.

The past few years, which cover the period of the world slump in prices dating from 1929, illustrate well the inflexibility of the system and the improvisations to which most of the Provinces have had to resort. Not the least striking feature of these years is that, in spite of the marked fall in prices, there is a progressive increase in the Land Revenue demand. This is illustrated in Table I.

This hesitancy to bring down the assessment to a figure more in accord with realities appears to be due to two causes; a natural desire to maintain and even increase the revenue in view of the growing cost of administration and an optimism, based on previous experience, that hopes that the set-back will be of a temporary nature. To reassess those Districts which fall for settlement during a period of low prices, at a figure in true accord with the actualities of the moment, would place them for the period of the settlement in a more favourable position in comparison with the Districts settled only a few years before. The system practically compels an assessment based on estimates during times of prosperity and the corrollary of that is a further system governing the rates of remission in periods of adversity. In a country like India, where the vagaries of the climate play so important a part in the prosperity of the country, the systematic organization of relief in the matter of revenue demand, and even actual famine relief, becomes an integral part of the system of administration. The relief thus contemplated, however, is relief from the consequences of monsoon failure or other calamity, such as the earthquake disaster in Bihar, calamities which only cause temporary set-backs. World-wide depression covering a series of years is a calamity without precedent.

It is easy to be wise after the event and it has to be remembered that the true nature of the crisis, its intensity and duration, only became apparent gradually in India as elsewhere. Under these circumstances, the natural course was to

Table I.

	Madras.		Bombay.			Central Provinces.		
	Assessment.	Remissions.	Assessment.	Supervisions.	Remissions.	Assessment.	Supervisions.	Remissions.
1929-30	—	—	—	—	—	120.3	11.7	9.6
1930-31	579.3	30.1	402.7	40.0	10.9	120.3	4.1	4.2
1931-32	602.1	91.9	404.6	46.3	11.0	123.8	7.7	1.9
1932-33	589.2	32.2	406.5	53.5	8.0	125.9	7.8	22.1
1933-34	591.9	26.8	408.7	44.5	13.1	125.9	7.0	4.0
1934-35	597.1	61.9	409.4	27.9	31.6	125.4	6.6	2.6
1935-36	608.3	41.0	410.2	43.6	29.8	—	—	—

apply the remedy devised to meet temporary crises with which India was familiar, due to natural calamities; suspension and ultimate remission of the revenue demand. The extent to which resort was had to these measures is indicated in Table I and it is noteworthy that each Province determined its own time to decide when the appropriate time came to admit that the full demand could not be met, that outstanding (suspended) demands could not be recovered and that a fresh start would have to be made with these unrealizable demands written off. These stages are indicated by the years in which there is a sudden rise in the figure of remissions.

As the crisis lengthened, these remedies proved inadequate and further action became necessary. Here, again, each Province acted independently and examples only can be given. In 1932-33, in the new Province of Scind, remissions to the extent of 20-25 per cent., of the kharif (summer crop) demand and 12.5 to 25 per cent. of the rabi (winter crop) demand were made for non-barrage areas; in the newly irrigated barrage areas the assessment had already taken into account the fall in prices. This relief was continued the following year and in 1935, the whole policy of relief was systematized by outright remissions where the percentage fall in prices in comparison with settlement prices showed relief to be desirable. In Madras by 1935-36 a scheme of remission at rates varying with the nature of the class of land and cultivation (wet or dry land and garden land) but attaining a maximum of 12.5 per cent. had been introduced which totalled a concession of 59.4 lakhs. In the United Provinces a more complex system of relief was evolved. Largely because of the extensive zemindari holdings in this Province, with revenue calculated on rents, the question of adjustment of revenue was closely interlocked with the question of the zemindars' capacity to realize rents. The two problems are inter-dependent and are dealt with below.

These remedies are in the nature of *ad hoc* remedies. The fundamental fact that Indian prices have now approximated to world prices, that the progressive rise which has characterized the past will no longer be maintained and that a system is required which recognizes that downward trends will be as common as upward trends and which will be equally applicable to both, appears to be hardly yet realized.

Tenancy.

With the security established by British rule and the growth of population, there has developed in most tracts a pressure on the land which has rendered possible the forcing up of rents in zemindari areas. As was explained in the earlier series of studies, all tenancy-legislation in the past is to be interpreted in that light. The objective of that legislation has been to maintain the balance of bargaining power as between landlord and tenant. Hence arose the system of maurosi (occupancy) rights in such a typical Province as the United Provinces. But it is very difficult to devise a flexible system which will maintain equilibrium as between landlord and tenant in the face of large price fluctuations; the endeavours in this direction have not been completely successful, and necessarily so—a stay to absorb the impact from one direction will not avail when the impact comes from the opposite direction. The enhanced returns which resulted from inflated war prices, fell largely to the tenant owing to the limitations placed by legislation on the increase of rents. There resulted on the part of many zemindars a movement to resume their land and cultivate it under their own supervision, a movement which, to the extent of permitting a resumption limited to the establishment of a home farm, received legislative sanction in certain of the later tenancy Acts, *e.g.* the Agra Tenancy Act of 1926.

The sudden fall in prices reversed the position. The Indian ryot is not characterized by thrift and did not, as a body, use this period of relative prosperity to build up reserves. With his fixed rent, the brunt of the burden fell on his shoulders. The first result of the depression of 1929 was a large increase in the number of rent cases during the following years but, with prolongation of the depression, these efforts for the recovery of rents proved ineffective: it is impossible to get blood out of a stone. Thus, by 1932, it is noted that one reason why landlords are reasonable is that rents cannot be recovered through the Courts because decrees cannot be executed. If he attempts execution, he has to buy the holding and cannot resettle it*. In the Report for the following year it is noted that lack of cash has resulted in certain parts of the Province in large areas of land passing into the hands of money lenders.

This increase of litigation, not unnaturally, created an atmosphere of hostility between landlord and tenant of which political malcontents were not slow to take advantage by organizing no rent campaigns—an aspect which need only be noted here. But that hostility is not entirely due to the intransigeance of the zemindar. As early as 1930-31 it is noted in Bengal † that the hands of the landlords are forced by the law of limitations and there is a very real danger that, through the operation of the Civil Courts, the cultivators' land will be lost to them. In subsequent Bengal Reports it is noted that few landlords could collect 50 per cent. of their current demand amicably during the past two or three years and, further, that there was difficulty in finding bidders in forced sales of immovable property (1933-34). The assessment during this period, it may be remarked, was continuously rising; from 298.7 lakhs in 1929-30 to 307.9 lakhs in 1933-34. The zemindar was, in fact, forced either to bring pressure on his tenants to pay rents, to default on his revenue demand and run the

* Bihar and Orissa, Land Rev. Report, 1932-33.

† Bengal, Land Rev. Admin. Report, 1930-31.

risk of having his land sold or to encumber his estate by resort to the money lender. The zemindar's position was unfortunate, too, in that they were faced with the necessity of discriminating between those tenants who really lacked the means to pay and those who deferred payment merely because others did so and in the hopes that, under sufficient pressure, some general measure of relief would be adopted from which they would benefit. This position appears to have been met, in Bengal at least, by the grant of remission of interest as an encouragement to voluntary payment.*

In some Provinces, Bengal and the Central Provinces, the position was partially met by taking statutory powers to establish Debt Conciliation Boards and, in the former Province, it is recorded that the claims of money lenders were reduced from nine to five lakhs. In the former Province advantage was taken of the opportunities afforded by the Land Improvement and the Agricultural Loans Acts to supply relief. In the latter Province two Acts, the Land Revenue(Amendment) Act IV and the Tenancy (Amendment) Act III were both passed in 1935 under the first of which the Local Government were empowered to reduce the assessment during the currency of a settlement for such period as it might think fit and, under the second, of which it was similarly empowered to make reductions in rent which took into account changes in the general conditions. In the North West Frontier Province the Redemption of Mortgages Act III of 1935 was passed which applied only to land under 30 acres in extent or to mortgages under Rs. 1,000. Under it, Court procedure for redemption or possession was replaced by the less costly process of petitioning the Collector of the District, petition by the mortgagor being allowed on the mortgagee's refusal to accept.

It was in the United Provinces, however, that the situation was met on the broadest lines. As early as 1929-30 the Commissioner of Meerut drew attention to the seriousness of the situation and commented that it was no longer an economic proposition for statutory tenants and sub-tenants, whose numbers had increased out of all proportion in recent years, to cultivate their lands. In 1931-32, on the recommendation of a Rent and Revenue Committee, temporary remissions of rent to the extent of 41.2 lakhs were granted, bringing the amount payable to the level of 1901 as prices had fallen to that level. Canal dues to the extent of 8.4 lakhs were also remitted. Further emergency action was taken by passing the Arrears of Rent Act VIII of 1932 protecting the tenant from ejectment on account of arrears of rent for Fasli 1337-38 (A.D. 1931-32) and by the issue of two notifications, the first under section 61 of the Civil Procedure Code exempting one-third of the produce from sale in the execution of a Civil Court decree, the second under section 68 of that Code transferring all Civil Court decrees for sale of land to the Collector.

But efforts were also made to provide a more permanent solution of the situation, the objective of which was to ensure adequate relief without causing such injury to credit as would make it more difficult to finance agriculture in the future. A Fluctuation Scheme was prepared by Mr. A. C. Turner for the adjustment of rent to revenue and approved by the Rent and Revenue Committee, but the previous remissions appeared adequate and it was not adopted. The Assistance to Tenants Act VIII of 1932 empowered the Court to remit rent up to 25 per cent. each year where no remission had previously been given and permitting payment to the Court over a maximum of two years, failure to make payment rendering the tenant liable to ejectment. The zemindar was also allowed a remission of revenue claim to the extent of 40 per cent. of this remission.

In 1933 a Reduction of Interest Bill was introduced in the Council but was withdrawn. Its objective was to define the maximum interest permissible on loans secured on immovable and other property, the rates to have retrospective effect. Its intention was to protect the smaller zemindar, those paying a Land Revenue claim of Rs. 5,000 or under, and tenant.

In 1934 a further series of Acts was passed. The position of the more seriously affected zemindars was alleviated by the Encumbered Estates Act XXV of 1934. Under it, a zemindar whose estate was encumbered, could apply for the case to be referred to a special judge. The Act is complicated but, in essence, places the execution of the special judge's decree in the hands of the Collector and, in the ultimate event, the creditors receive Government bonds while the estate passes under the Court of Wards. In the same year was passed the Regulation of Sales Act XXVI of 1934, which empowered the Collector to value land on the net profits calculated after ignoring any remissions of rent and revenue and to offer the land at that valuation to the decree holder with further somewhat complex instructions as to action should the decree holder refuse to take up the option. The Usurious Loans (Amendment) Act XXIII of 1934, covering a wider field than the abortive Reduction of Interest Bill of the previous year, amended the Act of 1918 and defined the maximum rates of interest permissible for the various types of loans. A further Act passed in this year was the Temporary Regulation of Execution Act XXIV which was applicable to cultivators defined as any one liable to pay rent for land let for agricultural purposes or one who was liable to pay a sum not exceeding Rs. 1 as a local rate, but excluding one against whom a decree has been passed either after the Act was passed, in favour of a Cooperative Society, or on account of a contract for the supply of sugar-cane in consideration of a money advance. Under it proceedings were stayed on deposition of 25 per cent. of the debt in Court, the remainder of the

* Bengal, Land Rev. Admin. Report, 1935-36.

debt being paid in annual instalments with certain limitations as to the amount of interest chargeable. Yet another Act, the Agriculturists Relief Act XXVII of 1934 was passed. It refers, however, to relief in the case of an agricultural calamity other than slump in prices and is, therefore, of a more general nature. It refers to a wide range of land holders and sanctions payment in instalments covering from four to fifteen years.

Lastly, the Land Revenue Act I of 1936 instructs the settlement officer to take into account the prevailing level of prices and substitutes rent rates sanctioned by the Board of Revenue for existing rates for a period of ten years or till the end of the settlement, whichever is earlier. It further provides for the substitution by the settlement officer on his own motion, in the course of settlement or during revisional operations, of rents and revenue modified to the fall in prices; such substitution to take the place of remissions. Such revised rents are stabilized for ten years and revenue for the period of the settlement.

The problem of land tenure, particularly as regards the relation of tenant to landlord, has not however, been solved by these measures. Unfortunately, the discontent which is natural to the conditions, has attracted political attention. The form taken, particularly in the United Provinces, is that of a no rent campaign. These influences cannot be followed here except to note that the development of this campaign led to the passage of the Agra Tenancy (Amendment) Act II of 1931 which empowered Government to notify areas in which arrears of rents, rates or cesses due to the landlords were declared recoverable as land revenue, thus enabling the landlord to recover through the Collector and not the Courts.

The story of the depression is writ large in the Reports of the cooperative movement. The details cannot be given here as their bearing reflects too indirectly on the subject of these studies. But the record, with overdues in some cases forming over 80 per cent. of the outstandings, with the solvency of the banks threatened through these being forced to further advances lest the members become insolvent and abscond, raises the question whether the cooperative movement can provide a real solution to the problem of agricultural indebtedness until the peasantry has learned by other means the need for greater thrift than it has yet learned in India. As noted above, that position has been reached in spite of the favoured position in which the co-operative societies have been placed, as noted above, by some of the Acts in the matter of recovery of debts.

One brighter point remains to be mentioned. This is the extent to which the situation has been alleviated, particularly in Bihar and the United Provinces, by the extension of the cultivation of sugar cane. This development had become possible through the new varieties bred at the Coimbatore Sugar Cane Research Station. While it has brought much money to the cultivators, it has raised problems of another order. Factories have sprung up like mushrooms, without regard to sources of supply and with the consequence that competition for the available supplies of cane is doing much harm to the industry. There is here raised the whole question of the organization of supplies from a host of small and independent peasant farmers. The question has been considered by a joint Committee of the two most interested Governments, those of Bihar and the United Provinces, and, at the time of writing, legislative action is proceeding.

(*To be continued.*)

THE PROPAGATION OF THE MANGO IN JAFFNA. I.*

A method of budding mangoes in the nursery for which much success is claimed has been devised at the Farm School, Jaffna, Ceylon. The stocks used are seedlings, 6 months to 1 year old, and budding is done at a height of about 10 inches from the ground, at a point where the bark is brownish or greyish in colour, the most suitable time being during a growth flush. To prepare the stock two parallel vertical cuts in the bark 1½-2 inches long are joined at the top by a horizontal cut. The flap thus cut is pulled gently down, leaving a patch of the cambium surface exposed. The bud, taken from the current season's growth and with the petiole removed except for a stub of 1/10 inch is cut so that it remains in the centre of a shield about 1-1½ inch in length and of an area slightly less than that of the prepared patch. The cut is made so that a wedge of wood remains underneath the shield. The shield is then placed in the centre of the patch on the stock plant in such a manner that its sides or extremities do not touch the edges of the patch. The flap is now pulled up over the bud, the whole being secured with waxed tape. In hot weather a bud is protected by a strip of dry plantain sheath 3 x 5 in. tied on the stock above and below. During wet weather the bud is covered with oil paper. After 2-3 weeks the tape is unwound and, if the bud is still green, it has probably united. The plantain sheath is replaced. A week later this covering is removed and the stock is ringbarked 1½-2 in. above the bud, the final cutting back of the stock taking place when the bud has grown to a length of 3 or 4 in.—(*Imp. Bur. of Fruit Prod., Hort. Abs.* Vol. VII, No. 3. p. 260, 1937.)

* By W. R. C. Paul and S. C. Guneratnam in *Trop. Agriculturist*, 1937, 88 : pp. 86-91.

WEST INDIAN NOTES.

(*Compiled by the Advisory Department, Imperial College of Tropical Agriculture.*)

The Sugar Industry.

The reaping season is now well advanced. Conditions have been extremely dry in Antigua, St. Kitts-Nevis and in Barbados, but wet in Trinidad and St. Lucia. Revised estimates differ in no marked degree from those stated in West Indian Notes published in this Journal in February, 1938, except in the case of Antigua where the revised estimate is 20,000 tons.

The Seventh Meeting of the Advisory Committee of the British West Indies Central Sugar Cane Breeding Station was held at the Imperial College of Tropical Agriculture, Trinidad, in February, 1938. The contributing Colonies were all represented at the meeting. The representatives were as follows:—Barbados, Dr. S. J. Saint, Director of Agriculture (Chairman of the Advisory Committee); Imperial College of Tropical Agriculture, Sir Geoffrey Evans, Principal; Trinidad, The Hon. E. J. Wortley, Director of Agriculture; Jamaica, Mr. F. E. V. Smith, Marketing Officer; Windward and Leeward Islands Mr. G. A. Jones, Commissioner of Agriculture. Dr. A. E. S. McIntosh, Geneticist of the Cane Breeding Station; Mr. C. C. Skeete, Assistant Commissioner of Agriculture; and Mr. P. E. Turner, Sugar Agronomist of the Department of Agriculture, Trinidad, also attended the meeting. Mr. E. J. Gregory, Manager of the St. Augustine Experiment Station, Trinidad, performed the duties of Secretary.

Some of the more important findings of the Committee are summarised below:—

Finances of the Station.

The Committee considered the financial position of the Station as detailed in a memorandum by the Chairman, and agreed that an increase in the funds of the Station is imperative if the proper functioning of the Station is not to be seriously impaired.

The Committee recommended that, in order to meet the estimated increase in the cost of the Station and to provide for the necessary capital expenditure, the income from the contributing colonies should be increased to £2,500, and that the extra income should be provided by Trinidad and Jamaica increasing their contributions to £1,200 and £825 respectively. The contributions of the Colonies concerned would then be:—

Colony.	Proposed Contribution.	Present Contribution.
	£	£
Trinidad ...	1,200	1,000
Jamaica ...	825	525
Leeward Islands	425	425
Windward Islands	50	50
Total ...	£2,500	£2,000

In view of the urgent necessity for funds to provide adequately for travelling, capital, and other expenses for the present financial year, the Committee strongly recommended that the half-yearly contributions from the subscribing colonies due on 1st of April, 1938, should be on the proposed new scale.

The Committee agreed that, if funds were available, the Geneticist should visit Jamaica and, if possible, should proceed to Louisiana to represent the Central Sugar Cane Breeding Station at the Triennial Conference of the International Society of Sugar Cane Technologists which is to be held in October, 1938.

Progress Report on the Work of the Central Cane Breeding Station.

The Geneticist submitted a progress report on the work of the Station for the period between the 6th and 7th meetings of the Advisory Committee. The Committee were satisfied that steady progress is being maintained, and wished to record that they considered the investigations concerned with rotting of cane, ratooning, and the use of the Zeiss Refractometer in testing for maturity, all of which had recently been initiated, should yield results of the highest practical value.

Testing for Variety Resistance to Mosaic Disease.

The Geneticist submitted a memorandum on the experimental work which has been recently commenced in Barbados for the testing of seedlings for degree of resistance to mosaic disease. The Committee agreed that these experiments would be of great value, particularly to Jamaica, and recommended their continuance.

Investigations into Varietal Resistance to the Small Moth Borer.

The Committee considered a progress report by the Entomologist of the Barbados Department of Science and Agriculture describing the investigations on the relation of *Diatraea saccharalis* to cane varieties and expressed the view that this work should be continued.

Plant Quarantine Station.

The Committee met the Committee of the Plant Quarantine Station and considered these methods of procedure which would facilitate the distribution of cane varieties and the organisation of the work of the two Stations. It was resolved that:—

(*a*) so far as can be estimated at present, the number of cane varieties to be sent to the Quarantine Station should be about twenty each year;

(*b*) notice of proposed shipments from Barbados including date and total number of varieties should be sent to the Quarantine Station as far in advance as convenient and again by the mail immediately preceding the shipment. Pedigrees and recommendations for distribution should, as far as possible, accompany the shipment.

(*c*) the Quarantine Station should notify the Cane Breeding Station as early as possible after the death of any seedlings in quarantine.

(*d*) when canes are available for distribution after quarantine, the Cane Breeding Station should be informed and should then make final recommendations for their distribution.

(*e*) the Quarantine Station should then furnish each Colony contributing to it with a list of canes ready for release together with their pedigrees and the recommendations of the Cane Breeding Station for each particular colony. Notice to each colony should also be given of intended despatch of recommended varieties.

(*f*) varieties not recommended by the Cane Breeding Station for any Colony should not be sent from the Quarantine Station unless by request which should be made only after careful consideration in order to minimise movement of planting material.

(*g*) both the Cane Breeding Station and the Quarantine Station should be notified by the contributing colonies as soon as any seedlings received from the Quarantine Station have been established.

(*h*) notice of proposed elimination of any varieties from the Quarantine Station should be sent to the contributing colonies and to the Cane Breeding Station. Such varieties would then only be retained by special request.

(*i*) a half yearly report, in September and March, should be made to the Cane Breeding Station of the general condition of the seedlings at the Quarantine Station.

The Cotton Industry.

The area planted in Sea Island cotton in 1936-37 amounted to 15,005 acres being 1,373 acres less than the acreage estimated by the West Indian Sea Island Cotton Association for that season and 2,619 acres more than the previous season. The increased acreage was planted chiefly in St. Vincent and Nevis, but there were also small increases in St. Kitts and Antigua.

The total production of Sea Island lint amounted to 1,637,704 lb. equivalent to 4,094 bales of 400 lb. each. This quantity was 400 bales more than the total production of the previous year. The increase was due to a larger crop in Montserrat, while production in the other Islands was little different from that of the previous year.

Production of Marie Galante lint amounted to 232,933 lb., equivalent to 582 bales of 400 lb. each, a decrease of about 33⅓ per cent. on the crop of the previous year.

Final production figures for the year 1936-37 are set forth in Table I.

TABLE I.

Production and Export Figures for Cotton in 1936-37.

Island.	Acres.	Production 1936-37. Lint. Clean lb.	Stained lb.	Total lb.	Bales of 400 lb.	lb. per acre.	Export 1937. Lint. Clean lb.	Stained lb.	Total lb.	Bales of 400 lb.
					Sea Island.					
Anguilla ...	400	28,294	3,146	31,440	79	79	28,294	2,414	30,708	77
Antigua ...	950	91,111	5,829	96,940	242	102	91,111	5,829	96,940	242
Barbados ...	153	7,967	237	8,204	20	54	8,002	—	8,002	20
Montserrat ...	4,380	637,723	22,636	660,359	1,650	151	637,723	22,636	660,359	1,650
Nevis ...	2,578	186,806	12,962	199,768	500	77	186,806	12,962	199,768	500
St. Kitts ...	1,190	192,140	24,671	216,811	542	182	163,103	5,270	168,373	421
St. Vincent	5,294	362,549	55,269	417,818	1,045	79	361,401	57,206	418,607	1,047
Virgin Islands (British)	60	5,704	660	6,364	16	106	5,517	647	6,164	15
Total ...	15,005	1,512,294	125,410	1,637,704	4,094	—	1,481,957	106,964	1,588,921	3,972
					Marie Galante					
Grenada ...	5,250	—	—	180,300	450	34	—	—	180,300	450
St. Vincent	745	—	—	52,633	132	71	—	—	52,633	132
Total ...	5,995	—	—	232,933	582	—	—	—	232,933	582

There was a further slight advance in the average prices obtained during the year as compared with average prices during the two previous years. Prices for the Montserrat strain ranged from 1/7 to 1/11, whereas for the St. Vincent strain the range was 1/11 to 2/-.

Production in 1937-38.

Conditions were more favourable at the end of 1937 and the beginning of 1938 than in the corresponding period for the previous season. In consequence good yields are being obtained in St. Vincent, Nevis and Antigua. The young crop in Montserrat and St. Kitts is suffering from dry weather conditions. The estimated production for the 1937-38 crop is set forth in Table II.

TABLE II.

Estimated Acreage and Production 1937-1938.

Island.	Acres.	Production.		
		Lint lb.	Bales of 400 lb.	lb. per acre.
		Sea Island.		
Anguilla ...	500	50,000	125	100
Antigua ...	2,000	170,000	425	85
Barbados ...	nil.	nil.	nil.	—
Montserrat	4,500	900,000	2,250	200
Nevis ...	3,000	360,000	900	120
St. Kitts ...	2,000	400,000	1,000	200
St. Vincent ...	4,500	560,000	1,400	124
Virgin Islands (British) ...	75	7,500	19	100
Total ...	16,575	2,447,500	6,119	—
		Marie Galante.		
Grenada ...	5,250	270,000	675	51
St. Vincent ...	700	40,000	100	57
Total ...	5,950	310,000	775	—

The Fruit and Vegetable Industry.

The tomato industry continues to hold a position of importance as a minor crop in Montserrat. Exports in 1937 amounted to 41,278 crates (20 lb.) having a net value to the grower of approximately £1,500. Many factors combined however to render the 1937 season an unfavourable one of for the grower and four-fifths of the crop was marketed at a very low average figure.

Efforts have been made since the 1937 season to improve conditions in the tomato industry in Montserrat. The cold storage plant has been renovated and enlarged, and encouragement has been given to the use of better methods in the field and the packing houses. Early shipments in the present season met with adverse criticism and low prices, but, with the invaluable assistance of the Trade Commissioner in Canada (Mr. C. R. Stollmeyer) and a keen desire on the part of shippers to satisfy market demands, the standard of mid-season shipments has greatly improved and satisfactory prices have been obtained.

As the result of the activities of the Peasant Agricultural Development Officer (Mr. C. A. Gomez) in Antigua, since the institution of this post in 1936, tomato cultivation for export has been undertaken on a considerable scale by peasants. Exports this season will be approximately 5,000 crates (20 lb.).

Exports of tomatoes from Bermuda and the Leeward Islands during the years 1934-37 are set forth in Table III.

TABLE III.

Tomatoes.

(*In* 20 *lb. tomato lugs*) 1934-1937.

Island.	1934.	1935.	1936.	1937.
Antigua ...	—	—	—	2,104
Bermuda ...	51,135	68,697	54,583*	28,392
Montserrat	7,378	18,631	45,869	41,278
Nevis ...	658	794	713	778
Total ...	59,171	88,122	101,165	72,552

Exports of oranges, avocado pears and mangoes from St. Lucia and the Leeward Islands during the years 1934-37 are set forth in Table IV.

TABLE IV.

(*a*) **Oranges.**

(*In* 2 *cu. ft. citrus crate*) 1934-1937.

Island.	1934.	1935.	1936.	1937.
Dominica ...	9,036	10,746	12,754	14,019
St. Lucia ...	374	291	126	107
Total ...	9,410	11,037	12,880	14,126

(*b*) **Avocado Pears.**

(*In* 20 *lb. tomato lugs.*) 1934-1937.

Island.	1934.	1935.	1936.	1937.
Antigua ...	—	—	—	127
Dominica ...	4,344	3,726	5,158	4,845
Montserrat	—	—		41
St. Lucia ...	2,245	3,857	3,336	3,960
Total ...	6,589	7,583	8,494	8,973

* This figure does not include 1,413 bushel crates.

TABLE IV—*Contd.*

(*c*) **Mangoes.**

(*In 20 lb. tomato lugs*) 1934-1937.

Island.	1934.	1935.	1936.	1937.
Dominica ...	4,084	3,462	8,616	6,056
St. Lucia ...	7,881	6,556	8,046	9,591
Montserrat	133	300	157	173
Total ...	12,098	10,318	16,819	15,820

The Coconut Industry.

Renewed interest was displayed in the coconut industry in 1936-37 owing to the increase in the world price of copra. But the present low level to which the price of copra has again fallen leaves little profit if any for the cultivator.

Table V gives the exports of copra and coconuts for the years 1934-37 in the Eastern British West Indies.

Brevities.

Mr. W. E. Bassett, assumed the duties of Curator, Montserrat on 3rd March, 1938.

* * *

Mr. G. A. Jones, Commissioner of Agriculture proceeded to the United Kingdom on four months leave on 23rd May.

* * *

The Commissioner of Agriculture visited St. Lucia and the Leeward Islands from 27th February to 7th April.

* * *

Mr. F. A. Squire, Entomologist, Cotton Pests Investigation, Windward and Leeward Islands, left St. Vincent on 25th May, on a visit to Antigua. During the next four months he expects to visit the Virgin Islands, Puerto Rico, Montserrat and Barbados, before returning to St. Vincent.

Mr. J. B. Hutchinson, Cotton Adviser to the Commissioner of Agriculture, visited Montserrat, St. Kitts, Nevis and Antigua from 12th to 28th April.

* * *

Mr. J. Cook has been reappointed Secretary of the Advisory Committee in England of the West Indian Sea Island Cotton Association for a further period of twelve months from 1st April, 1938.

* * *

The Assistant Commissioner of Agriculture visited Dominica in March to conduct a reconnaissance survey of the forest lands in certain inland districts where plans for road construction are under consideration.

* * *

Mr. F. G. Harcourt, M.B.E., Agricultural Superintendent, Dominica, who has been seconded for administrative work in Dominica and Montserrat since May, 1937, proceeded to England on six months leave on 22nd April, 1938.

* * *

Mr. R. G. Fennah, Entomologist, Citrus Pests Investigation, Windward and Leeward Islands spent the month of April in Montserrat and the first fortnight of May in Dominica. He returned to St. Lucia on the 15th May. He will proceed on four months leave at the end of July.

* * *

The West Indian Sea Island Cotton Association has prepared a stand in the West India Court at the Empire Exhibition at Glasgow. Many registered users of the Association's trade mark are supplying goods for display. The dressing of the stand has been undertaken by the West India Committee.

* * *

Mr. S. H. Evelyn, Cotton Research Officer of the Empire Cotton Growing Corporation in St. Vincent, has accepted an appointment at the Corporation's station at Wad Medani in Sudan. Mr. Evelyn sails for England in September where he expects to remain for about nine months undertaking a special course. At the end of this period he will proceed to the Sudan.

TABLE V.

Exports of Copra and Coconuts, 1934-1937.

Place.	1934.		1935.		1936.		1937.	
	Copra Thou. lb.	Coconuts. Thou. nuts.	Copra Thou. lb.	Coconuts. Thou. nuts.	Copra Thou. lb.	Coconuts. Thou. nuts.	Copra Thou. lb.	Coconuts. Thou. nuts.
Trinidad	17,929	9,850	8,765	5,491	9,438	4,560	17,277	5,021
St. Vincent	2,016	980	840	3,392	788	2,795	1,845	1,671
St. Lucia	676	2,616	482	2,815	685	3,410	905	2,993
Dominica	247	104	279	230	274	719	116	1,046
Total	20,868	13,550	10,366	11,928	11,185	11,484	20,143	10,731

Mr. E. T. Ward, who has been appointed Agricultural Superintendent, St. Lucia, is expected to arrive in St. Lucia in August or September, 1938.

* * *

Mr. F. S. Chance has been appointed by the British Cotton Growing Association to represent the Association on the Advisory Committee in England of the West Indian Sea Island Cotton Association (Incorporated) in the place of the late Alderman H. Astley-Bell.

The first joint meeting of the Eastern and Western Groups of the British West Indies Fruit and Vegetable Council and the third meeting of the Eastern Group Council were held at the Imperial College of Tropical Agriculture, Trinidad, in February, 1938. A report of the proceedings of the two meetings has been published. Reference was made to the more important findings of the meetings in the editorial columns of the April number of this Journal.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Deterioration of Natal Raw Sugars in Storage. —*By F. W. Hayes.*

Batches of 10 bags (1.05 tons) from each mill after sampling and analysing were buried in a large stack of other bags, 5 bags being kept outside the stack as a control. After a month's storage, they were re-sampled and re-analysed, and left piled separately for 5 weeks. Then they were gain placed in the centre of a large stack as at first, where they stayed till their final removal after 7½ months' storage, being finally re-sampled and re-analysed. Results for the pol. and r.s. are given below for the bags inside and outside the stacks.

Mill.	Inside Stack.		Outside Stack.	
	Pol.	R.S.	Pol.	R.S.
DL ...	—0.25	+0.06	—0.30	+0.07
AKL ...	—0.05	+0.08	+0.10	—0.04
UZA ...	—0.10	+0.06	+0.10	—0.12
DE ...	—1.85	+1.28	—0.25	+0.06
GS ...	—0.35	+0.04	+0.10	—0.03
TSC ...	—0.45	+0.10	—0.60	+0.06
ZSM	No change	—0.06	+0.05	+0.06
ACF ...	—2.30	+1.16	—02.5	+0.01
CP ...	—1.05	+0.91	—0.05	+0.09
RE ...	—0.30	+0.12	—0.65	+0.12
ESP ...	—3.70	+2.75	+0.45	—0.01

It is immediately apparent that the behaviour of the outside bags is quite dissimilar to that of the same sugar when stored inside a large stack. Take the ESP sample, for example, it showed the high fall of pol. and increase of reducing sugars inside the stack, but it also exhibited the highest rise in pol. outside it. It is also noticeable from the table that with most "inside" samples a proportionate rise in r.s. accompanies the fall in pol., but in the "outside" bags very little increase is shown.

(Here follows a good general review of the most important work done on sugar deterioration by Owen (1), Kopeloff (2), Brown (3), van der Biji (4) and others as recorded in this *Journal*.) It is known that torulae occur in Natal raw sugars. They show their effect by a lower Clerget than direct pol., more particularly in what have been proved to be the better keeping raws. By their action they generally bring about a lightening in the colour of the sugar.

When a large lump of deteriorated sugar falls apart, it is seen to have a distinctly patchy appearance. The white patches show where the deterioration has proceeded to an advanced stage. There the crystals are soft and bleached, owing to the acidity developed and the CO_2 evolved. Darkened rings indicate the most rapid increase in the r.s. In about 70 per cent. of cases, the white patch surrounded a small black particle of burnt bagasse, this forming a core, as it were. It seems very likely that this air-borne particle had carried the first infection.

In the discussion following, L. Blacklock remarked that out of all this comes abundant proof that the most vital factor affecting a raw sugar during storage is its moisture content. This may be qualified by the extent of its contamination by moulds and yeasts, but a badly infected sugar will deteriorate even more rapidly when coupled with a higher moisture content. It is possible to make a raw sugar in Natal which will store for 4 or 5 months without appreciable loss in polarization. Probably the time has come when the old moisture penalty scale should be superseded by a safety factor scale. G.S. Moberly moved that in the opinion of the Association a penalty scale based on the safety factor should be adopted rather than one based on the moisture content. It was unanimously voted by the meeting that this should be adopted as a recommendation of the Congress.—*Int. Sugar Jr.* Vol. XL, No. 472, pp. 155-56, 1938.

(1) *I.S.J.*, 1919, pp. 277, 334; 1922, pp. 581, 644.
(2) *I.S.J.*, 1920, pp. 282, 523, 591.
(3) *I.S.J.*, 1918, pp. 226, 265, 319, 370.
(4) *I.S.J.*, 1921, pp. 320, 482, 504.

NOTICE.

The Editor is prepared to purchase copies of Vol. XIV No. 1, January, 1937 at the rate of 1s. per copy.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Russian Apatite Mines.

The great new phosphate mine at Kirovsk, Kola Peninsula, N.W. Russia, developed in eight years, is one of the industrial wonders of the world. This achievement is entirely due to Russian enterprise and energy. Owing to the close collaboration of seven organizations, the U.S.S.R. Academy of Sciences, the Arctic Institute, the Apatite Trust, the Scientific Institute of Fertilizers, the Central Geological and Prospecting Institute, the Rare Metals Trust, and the Leningrad Geological Trust, apatite is now being mined at the rate of 2 million tons per annum, and a reserve of 2,000 million tons has been established. The southern face of Kukisvumchorr Mountain has been blasted back into five broad ledges to a height of 1,500 feet. There are now more than twenty miles of underground galleries seven feet in height, electrically lit, and with electric haulage. A tunnel which admits the ordinary freight train has been driven to the heart of the mountain to facilitate loading. The social and industrial development of the region which, nine years ago, was a desolate arctic waste peopled by a few Lapp families, has kept pace with its scientific and technical investigation. The new town of Kirovsk with 40,000 inhabitants, and villages with the picturesque names of Nepheline and Apatite, have been built, and hundreds of miles of railway has been electrified. Besides apatite, nepheline is mined for use in the ceramic industry, and for its content of potash as fertilizer.—(*Nature*, Vol. 141, No. 3565, 1938, p. 354.)

* * *

Molybdenum and Cattle Nutrition.

A further example of the significance of "trace elements" in the nutrition of livestock has recently been published by investigators at the Jealott's Hill Research Station of Messrs. Imperial Chemical Industries (I.C.I.), Bracknell, England, (Letter to *Nature*, 26th March, 1938, p. 553; Messrs. W. S. Ferguson, A. H. Lewis and S. J. Watson). These workers describe a large area (some 20,000 acres) of pasture land in Somerset which cannot be grazed by cows during April to October without milk yields falling rapidly, causing extreme diarrhoea, marked loss in condition, and even death. Such land is described as "teart", and spectrographical examination of the pasture herbage has shown the occurrence of molybdenum in it, while herbage of neighbouring "non-teart" lands showed little or none of this rare element. No correlation has yet been found, however, between total or acid-soluble molybdenum in the soil and that in the herbage. Soluble molybdates fed to cows (1.36 g. molybdenum per head per day) produced extreme scouring and loss of condition, similar to that which occurs in the "teart" fields of Somerset. It is stated that horses grazed on "teart" lands are not affected by the malady.

Growth Controlling Substances in Plants.

In a series of preliminary experiments with these substances, Dr. H. L. Pearse has examined the reaction of leafless woody cuttings to treatment with root-forming substances (*Ann. Bot.* N.S. 2, No. 5, 227; 1938). The experiments were performed on leafless cuttings of *Salix vitellina*, and the synthetic root-forming substance was indole-butyric acid in lanolin paste in one series and indole-butyric acid dissolved in water in the other. Some interesting results were also obtained from partial and complete ringing. It was found that treatment of the basal end of cuttings stimulated root-formation at that end. If, on the other hand, the apical end was treated, root-formation was accelerated throughout the length of the stem, though acceleration was at a maximum at the node nearest the apex and the number of roots decreased from apex to base. Ringing experiments showed that the indole-butyric acid was transported downward in the stem through tissue outside the xylem. It is suggested that the indole-butyric acid itself was the active agent concerned in root formation, and was used up or chemically changed in the process, since when the portion of the base which had been treated was removed, the effect of treatment was eliminated, but if more indole-butyric acid was added, then further response occurred.—(*Nature* Vol. 141, No. 3569, p. 561, 1938.)

* * *

Structure of Rubber.

With the more extensive data from new X-ray diffraction patterns of stretched rubber, an attempt has been made by H. A. Morss, jun. (*J. Amer. Chem Soc.*, 60, 237, 1938) to find the true unit cell. No really satisfactory solution was reached but some points of interest are described. It appears that the carbon atoms of a molecular chain are not coplanar in stretched rubber. The reason appears to be the large repulsive forces which would have to exist in that configuration. In rotations on the single bonds during stretching and retraction the interatomic forces are probably repulsions in the dominating pairs, the prevailing H-H distances in the closest pairs suggesting repulsive rather than attractive forces. Repulsions give a plausible explanation of the form of the outer part of the stress-strain curve. A structural formula of rubber is proposed. The density of crystalline, stretched rubber as calculated from the unit cell is about 1.00 when the angle between the two independent sets of planes which reflect the two equatorial spots is changed from 90°, which first suggests itself, to 109.5°. This value agrees better with the experimental value 0.96 than the values calculated from other structures.—(*Nature*, Vol. 141, No. 3569, p. 561, 1938.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.).

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
31st March	5	0	8	9¾
7th April	4	11¼	8	8¼
13th April	4	10½	8	6¾
21st April	5	0	8	6¾
28th April	5	0¾	8	9¾
5th May	5	0	8	10½
12th May	5	0	8	9¾
(13*th May*, 1937) ...	6	5¾	10	1½

After a further decline in prices due to lack of activity in raws and refined, and a certain amount of May liquidation the market has, as we go to press, been more cheerful with values fractionally higher. The recovery on the No. 4 Contract in New York, the absence of any pressure to sell raws by producers, the better atmosphere surrounding international politics and better U.K. trade returns have all been steadying factors and have led to a rather improving tendency.

* * *

BANANAS.—There has been a much better demand and conditions are firmer with Jamaicas £2 per ton higher at £19 10*s.* delivered London and £19 5*s.* nearest station Provinces. Brazilians are £1 higher at £15 10*s.* delivered London and £16 10*s.* Provinces.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian Giza 7.*	*F.G.F. Sakel.*
25th March ...	4.97	7.24	8.19
1st April ...	4.91	7.13	8.08
8th April ...	4.79	7.09	8.04
14th April ...	4.89	7.12	8.07
22nd April ...	4.94	7.09	8.04
29th April ...	4.80	—	—
6th May... ...	4.69	—	—
13th May ...	4.77	—	—
(14*th May*, 1937) ...	7.12	—	11.05

There have been hopes of a rise in raw cotton prices as a result of the change in the financial policy of President Roosevelt, but the response in Liverpool to the advance in New York has been disappointing. A good deal of the recent weakness in cotton prices has been due to Bombay selling. From a supply point of view the position remains bearish specially as there is a likelihood of a larger output of outside growths. A few sales of Best Sea Island Cotton have been made at 2¼*d.* per lb. Other sales reported at 20*d.*, and for Montserrat at 19*d.* per lb.

COCOA.—Since last writing the Commission appointed by the British Government to investigate selling conditions on the Gold Coast have concluded their investigations, and as a result an export quota had been fixed at 55,000 tons for the first quota period, namely from 27th April to 31st May 1938. Meanwhile some disputes have arisen among the farmers who hesitate to sell large quantities at prevailing low prices, making it exceedingly doubtful if shipments in the first quota will exceed 35,000 tons. At present Accra cocoa is quoted at 20*s.* c.i.f. and locally $5.00 per fanega is paid for Plantation cocoa.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

RUBBER.—Quotations for plantation sheet have ranged as follows :—

	Pence per lb.
30th March	5 5-16
6th April	5 7-16
13th April	5 5-16
20th April	6 1-8
27th April	5 13-16
4th May	5 5-8
11th May	5 7-8
(13*th May*, 1937)	10 5-16

There was some disappointment felt in the market at the International Regulation Committee's decision to postpone the fixing of the exportable percentage quota for the July-September quarter, to May 31st, and prices following this announcement fell. When President Roosevelt's recovery programme was published, however, the tone became steadier and prices advanced once more. The upward reaction on Wall Street and America also generally helped materially to stimulate a more hopeful outlook but it remains to be seen whether this better sentiment can be sustained.

* * *

COPRA.—There has been some recovery in prices and West Indian f.m.s. is 7*s.* 6*d.* higher at £12 7*s.* 6*d.* c.i.f. London.—(*West India Committee Circular*, 21*st April*, 1938.)

* * *

LIME PRODUCTS.—*Lime Oil.*—Small sales of Handpressed have been made at 32*s.* 6*d.* to 34*s.* per lb. Distilled continues neglected, with the quotation nominal at 22*s.* 6*d.* per lb., but purchases are possible at below this price by negotiation.—*Lime Juice.*—There is no inquiry for Concentrated, and Raw is quiet and unchanged at 1*s.* 9*d.* to 2*s.* 3*d.* according to quality.—(*West India Committee Circular*, 21st April, 1938.)

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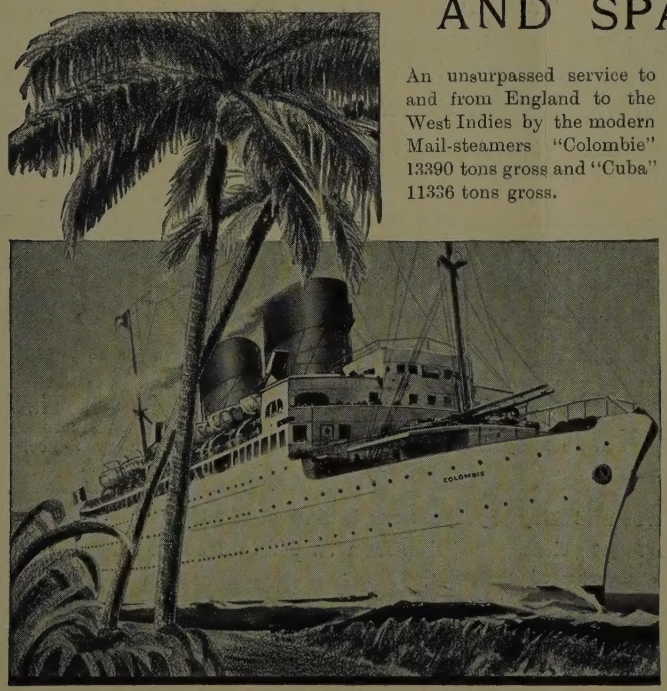

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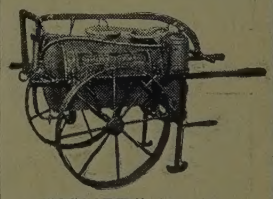

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